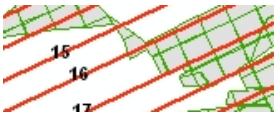
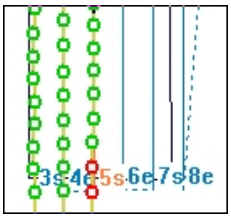
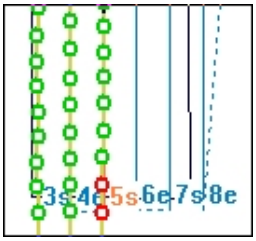
2.1. IMAGING SUB-SYSTEM

No	COMPONENT	SPECIFICATIONS		
1	Software **EnsoMOSAIC FlightPlan**	• Numeric flight planning in MS-Excel • Graphical flight line design in ArcGIS and in QGIS • Exporting the flight lines into the navigation software NavCam		
2 a	**EnsoMOSAIC** Flight Control Hardware and Software **"Aircraft power"**	**Hardware** • System synchro integrating GNSS and cameras with flight control software • GNSS unit, specified at Item 3 • Input 12 V or 24 V from external power supply • Output 110V or 220V, 12 V optional • Cabling • Housing dimensions: 45 x 16 x 36 cm • Weight 7 kg **Software NavCam** • Display of flight track and route and the position of the aircraft. • Display of aircraft deviation and other flight data for the pilot • Trigger camera • Store flight log and image metadata	 	
2 b	**EnsoMOSAIC** Flight Control Hardware and Software **"Internal battery"**	**Hardware** • System synchro integrating GNSS and camera with flight control software • GNSS unit, specified at Item 3 • Battery to support GNSS unit and camera for min 6 hours. • Cabling • Housing dimensions: 35 x 14 x 29 cm • Weight 6 kg **Software NavCam** • Display of flight track and route and the position of the aircraft. • Display of aircraft deviation and other flight data for the pilot • Trigger camera • Store flight log and image metadata	 	

3a	**GNSS**	• Novatel FlexPak6 ▪ Single frequency L1 ▪ GPS, DGPS, SBAS ▪ Accuracy, Single point L1 1.5m (RMS) • Novatel Antenna ▪ GPS L1 ▪ FAA certified		
3b	**GNSS**	• Novatel FlexPak6 ▪ Dual frequency L1/L2 ▪ GPS, DGPS, SBAS, L-band ▪ Accuracy, Single point L1/L2 1.2m (RMS) ▪ Accuracy, SBAS 0.6m (RMS) ▪ Accuracy, Terrastar 0.1m (RMS) (optional) ▪ Accuracy, RTK 1cm+1ppm (optional) • Novatel Antenna ▪ GPS L1/L2 + L-band ▪ FAA certified • Cellular modem (not included) ▪ for GSM network RTK signal		
3c	**GNSS**	• Item 3b + GLONASS		
3d	**GNSS / INS**	Novatel SPAN-IGM-A1 • Novatel OEM615 ▪ Dual frequency L1/L2 ▪ GPS, DGPS, SBAS, L-band ▪ Accuracy, Single point L1/L2 1.2m (RMS) ▪ Accuracy, SBAS 0.6m (RMS) ▪ Accuracy, Terrastar 0.1m (RMS), (optional) • IMU ADIS-16488 ▪ Gyroscope bias stability 5 deg/h ▪ Roll+Pitch accuracy, RTK mode 0.035 deg ▪ Heading accuracy, RTK mode 0.150 deg • Novatel Antenna ▪ GPS L1/L2 + L-band, FAA certified		
3e	**GNSS / INS**	Novatel SPAN-IGM-S1 • Novatel OEM615 ▪ Dual frequency L1/L2 ▪ GPS, DGPS, SBAS, L-band ▪ Accuracy, Single point L1/L2 1.2m (RMS) ▪ Accuracy, SBAS 0.6m (RMS) ▪ Accuracy, Terrastar 0.1m (RMS), optional • IMU STIM300 ▪ Gyroscope bias stability 0.5 deg/h ▪ Roll+Pitch accuracy, RTK mode 0.015 deg ▪ Heading accuracy, RTK mode 0.080 deg • Novatel Antenna ▪ GPS L1/L2 + L-band, FAA certified		
3f	**GNSS / INS**	Novatel SPAN-CPT • Novatel OEM628 ▪ Dual frequency L1/L2 ▪ GPS, DGPS, SBAS, L-band ▪ Accuracy, Single point L1/L2 1.2m (RMS) ▪ Accuracy, SBAS 0.6m (RMS) ▪ Accuracy, Terrastar-D 0.06m (RMS), optional • IMU CPT ▪ Gyroscope bias stability 1 deg/h ▪ Roll+Pitch accuracy, RTK mode 0.015 deg ▪ Heading accuracy, RTK mode 0.030 deg • Novatel Antenna ▪ GPS L1/L2 + L-band, FAA certified		

3g	**GPS / INS**	Vectornav VN-200 • GPS ▪ Single frequency L1 ▪ GPS, SBAS ▪ Accuracy, Single point L1 2.5 m (RMS) ▪ Accuracy, SBAS 2.0 m (RMS) • IMU ▪ Gyroscope bias stability <10 deg/h ▪ Roll+Pitch accuracy, 0.1 deg ▪ Heading accuracy, 0.3 deg • Antenna ▪ GPS L1		
4	**Camera mount**	• Constructed / supplied locally to fit the airplane to be used for imaging		
5	**Battery and charger**	• For testing the flight equipment on the ground • For running the flight equipment disconnected from aircraft power source		
6a	**Laptop computer** Lenovo X260 or equivalent for flight management	• With USB 3.0 port for GNSS and trigger signals • With fixed external display port or USB 3.0 port for navigation display • Disk: 500 GB HDD • Processor: Intel Core i7 • Memory: 4 GB DDR • Win 10 Pro 64 • 9-cell battery, power back-up from flight control hardware for 5 hours flight time		
6b	**Laptop computer** Lenovo X260 or equivalent for image storage	• With USB 3.0 ports for image input • Disk: 512 GB SSD • Processor: Intel Core i7 • Memory: 8 GB DDR • Win 10 Pro 64 • 9-cell battery, power back-up from flight control hardware for 5 hours flight time		
7 a	Camera **Canon EOS 6D** CIR configuration	• 36 x 24 mm CMOS sensor, 21 Megapixels (5472*3648). • Colour depth 14 bits (RAW) or 8 bits (JPG). • Image storage into SD/SDHC/SDXC memory cards • Maximum shutter speed 1/4000 sec • With battery, AC-adapter and battery charger • With lens Canon 50 mm/1.4 USM • With lens Canon 28 mm/2.8 IS USM • With a protective case for the camera and accessories • **Geometrically calibrated,** with certificate		
7 **b**	Camera **Canon EOS 5Ds R** RGB configuration	• 36 x 24 mm CMOS sensor, 50.6 Megapixels (8688*5792). • Colour depth 14 bits (RAW) or 8 bits (JPG). • Image storage into CF or SD/SDHC/SDXC memory cards • Maximum shutter speed 1/8000 sec • With battery, AC-adapter and battery charger • With lens Canon 50 mm/1.4 USM • With a protective case for the camera and accessories • **Geometrically calibrated,** with certificate		

7 b	Camera **PhaseOne iXU-RS1000**	• Sensor 11,608 x 8708 pixels, 53.4mm x 40.0mm • RAW image storage into external storage device • With lenses as specified in the main document • With software iX Capture • With software Capture One • **Geometrically calibrated,** with certificate		
7 c	Camera **Rikola hyperspectral**	• Default spectral range 500 – 900 nm • Min spectral resolution 10 nm, FWHM • Spectral step <1 nm • Up to 50 frames on single exposure in-flight • 16 frames / 1.6 seconds • Integration time 5-15 ms • Default spectral image 1024 x 1024 pixels • FOV 37°, horizontal and vertical • Power consumption <6 W • Weight 700 g • Size 75 mm x 90 mm x 152 mm • With GPS and irradiance sensor • With control and band matching software • Default image format ENVI, output also TIF • **Calibrated**		
8	Memory cards **Sandisk or equivalent**	• Capacity 64 or 128 GB • 2 units		
9	Navigation display **Niceview 8"** TFT SVGA	• TFT display of 8 inches • Resolution max 1024*768, native resolution 800x600 • Display of the deviation of the aircraft from the flight line for the pilot • Connects to a parallel display port of the navigation laptop • Control of the flight control software by touch screen		
10	**GIS software** **QGIS or ArcGIS**	• Design of flight lines • Also needed in image processing sub-system for orthomosaic resampling		
11	**Camera Pod**	• For Cessna 172, 182, 206, GA8 and similar models • For SLR and medium format cameras • One or two cameras or other sensors • Mounts to left / right / both wings • Vertical or oblique imaging • GNSS and battery compartment • Wireless or cable control • Payload 10 kg • Diameter 230 mm, length 760 mm • STC by Transport Canada		
12	**Training,** **Imaging**	• Basics of aerial imaging and camera operation • Definition of flight parameters • Design of the flight lines • Electricity systems		

	2 days	• Installation of the camera • Camera configuration • Installation and operation of the orientation sensor • Aircraft navigation and camera triggering with laptop and NavCam • Camera control • Verification of flight track and altitude • Control of image quality • Test flights and training flights		

2.2. IMAGE PROCESSING SUB-SYSTEM

No	COMPONENT	SPECIFICATIONS		
1	**Software** **EnsoMOSAIC Fusion**	• Automatic location of tie points from overlapping images applying feature extraction • Image rectification by block adjustment • A set of spectral corrections • Dense point cloud generation • Automatic DEM generation • Output mosaic resampling with internal or external DEM • Runs on Windows 7/8/10, 64 bits • Processes large, medium and small format images • Processes single flight line imagery for corridor mapping • Processes multispectral and hyperspectral imagery • Processes data of different camera types and multi-camera systems simultaneously (camera fusion) • Does not require initial orientations from IMU, optional • Software manual and tutorial videos	EnsoMOSAIC	
2	**Computer** PC	• Minimum RAM 8 GB, CPU 1 GHz, disk 100 GB • Recommended RAM 32 GB, CPU 3 GHz, disk 750 GB • Min 17" monitor • MS Win 7/8/10, 64 bit		
3	**Training** **Image processing** 2 days	• Camera calibration • Organizing the data on hard disks • Creating EnsoMOSAIC image block • Automatic and manual tie point measurement • Entering ground control points • Aerial triangulation • Automatic point cloud generation • Spectral corrections • Mosaic resampling • Quality control and error correction		

2.3. IMAGE UTILIZATION SUB-SYSTEM

No	COMPONENT	SPECIFICATIONS		
1	Monitor **LG Cinema 3D** or equivalent	• 3D display resolution 1920 x 1200 (active 3D) or 1920 x 600 (per eye, passive 3D) • Interface DVI + VGA • Size 24 " diagonal • With polarized or active lenses (2 pieces)		
2	**Computer** PC	• Minimum RAM 1 GB, CPU 1 GHz, disk 100 GB • Recommended RAM 4 GB, multi-core CPU 2 GHz, disk 500 GB Graphics card: • Minimum for passive stereo: OpenGL support • Recommended for active stereo: NVIDIA Quadro 4000		
3	**EnsoMOSAIC Agri**	• QGIS plugin + field reflectance targets • reflectance plates 50 * 50 cm, 2%, 23% and 44 % • Reflectance and true NDVI calculation • For any frame cameras (3 – n bands) • Prescription maps in vector format • In case of modified CIR cameras cleans unwanted NIR from RED and Green, output NIR, RED, GREEN		
4	**Software** **EnsoMOSAIC 3D**	• XYZ – point cloud from oriented images • DSM and DTM calculation • Z -points from 1 or 2 stereo models • Runs on multi-core CPUs • DSM export to EnsoMOSAIC for near-true orthos • 3D visualization • 3D digitizing into external database (e.g. ArcGIS, AutoCAD and MicroStation) • Calculation of contours and volumes		
5	**Training** **Image utilization 3D** 2 days	• Hardware and software setup • Stereoscopic viewing • Introduction to 3D analysis • Importing image orientations • Calculating point clouds • Calculating elevation models • Calculating contours • Volume calculations • 3D-digitizing • Internal and external databases		

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2.4. MAINTENANCE AND SUPPORT

No	COMPONENT	SPECIFICATIONS		

1	Maintenance and support for EnsoMOSAIC, EnsoMOSAIC 3D NavCam,	• All new software versions and documentation, delivered electronically or through Support Area Services.
		• Maintenance of e-mail address for contacts with the Customer
		• Technical support for the Software by e-mail, telephone and internet.
		• Right to order at hourly fee the following additional maintenance and support services:
		  • Analyzing and processing data of the Customer
		  • Solving user errors and operator-related problems
		  • Project planning and implementation for imaging and image processing
		  • Training in Software operation
		  • Software development specified by the Customer		

Color key:

	Items provided by MosaicMill
	Items acquired by the client
	Optional items
	Items not required or not recommended in the proposed configuration